PBAR NOTE 590
EVALUATION OF THE 4-8 GHZ DEBUNCHER UPGRADE PROTOTYPE STOCHASTIC COOLING PICKUP AND KICKER TANKS

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INTRODUCTION

By mid-June of 1998 a prototype Stochastic Cooling pickup tank for the 4-8 GHz Debuncher Upgrade will be built. By late June of 1998, a kicker tank will be built. These tanks are designed for Horizontal Band 1, which is centered at 4.35 GHz and spans 1.1 GHz. This note will give a description of the performance criteria that will be used to evaluate the prototype tanks. This note will not go into a detailed discussion of the design but highlight the components that strongly influence the overall performance of the prototype

THE PICKUP TANK

The pickup tank will contain two arrays, one for each sub-band. The major questions that will be asked about the pickup are:

1. Is it possible to assemble all components into the tank?
2. To what vacuum will the tank pump down?
3. What is the temperature profile across the arrays, the absorber, the amplifiers, and termination resistors?
4. What is the flow of Helium needed to keep the tank cold.
5. Will the tank handle thermal cycling?
6. What is the microwave noise temperature of the array?

The major pickup tank components (not necessarily in order of importance) are:

1. The tank stands.
   The stands should allow each end of the tank to move independently with a vertical and horizontal range of motion of ±0.5 inches.
2. The vacuum tank and flanges.
   The tank should pump down to a pressure of 2.0×10^{-8} Torr. The location of the flanges should be such that assembling the array into the tank (including microwave and cryogenic connections) is possible (if not easy).
3. The cryogenic components.
   These components include shields, insulation, interconnects, and array cooling channels. The entire array, especially the absorbers, should be kept below 10K. The cryostat's static heat leak should be less than 25W at 4.5K, and less than 50W at 80K. Two phase pressure drop should be less than 0.3 psid at 700 SCFMAir.
4. The array supports.
   Positioning reproducibility-stability after cool-down less should be less than 0.020 inches.

5. The array.
   The array includes the output waveguide pockets, the slotted foils, the launchers, the absorbing sidebars, and the isolating absorber pockets. The launchers should have a reflection coefficient less than –20dB. The absorbing sidebars should be able to handle repeated thermal cycles. The isolating absorber pockets should have attenuation greater than 25 dB. The temperature of all absorbing material and the termination resistor should be less than 10 K.
6. The hybrid.
   The insertion loss of the hybrid including the connecting cables to the array should be less than 0.25 dB. The phase imbalance between the legs of the hybrid should be less than 10 degrees throughout the band.
7. The low-noise amplifiers.
   There will be four low noise amplifiers in the tank. One for either difference or sum mode and for the lower or upper sub-band. The amplifiers should have a noise temperature of less than 30K. The amplifiers should dissipate less than 500 mW. The insertion loss between of the cables between the amplifier and the output flange should be less than 2 dB.
8. The outside amplifier plate.
   The location and the supports for the outside amplifier plate should be allow for convenient access and not interfere with other tank components.

THE KICKER TANK

The kicker tank will contain 4 short arrays. The major issue of the kicker tank is the vacuum load generated by the absorbers dissipating microwave power. The kicker vacuum tank will be much different than the pickup tank because of the rigid waveguide outputs from the kicker array. The major questions that will be asked about the kicker are:

1. What is the vacuum in the beam-pipe while 600 Watts of TWT power is being pumped into the tank?
2. How easy is it to connect the rigid waveguide outputs to the vacuum tank flanges?
3. What is the reflection coefficient into the ports for both the sum and difference mode?

The major pickup tank components (not necessarily in order of importance) are:

1. The tank stands.
   Because of the rigid waveguide outputs, the tanks and therefore the stands of the kicker will be different than the pickup. The kicker stands should also allow each end of the tank to move independently with a vertical and horizontal range of motion of ±0.5 inches.
2. The vacuum tank and flanges.
   The tank should pump down to a pressure of 2.0×10^{-8} Torr while subjected to 600 Watts of microwave power. Unlike the pickup, the flanges for the microwave connections will be bellows because of the rigid waveguide connections. These bellows should be large and flexible enough to make the array connections and handle thermal stresses.

3. The power coaxial to waveguide launcher.

   There will be eight of these launchers on the tank. They will be water-cooled externally. Each launcher should handle 75 Watts. The reflection coefficient of each launcher should be less than –15 dB.

4. The rigid waveguide.

   The rigid waveguide connects the coaxial launcher to the array. The waveguide should be able to handle misalignments between the array and the coax launcher on the order of 0.100 inches. The difference in delay between pairs of waveguide should be less than 5 pS. The reflection due to the elbow connection between the waveguide and the array should be less than –20 dB.

5. The power load.

   There will be eight power loads in the waveguide. They should be able to handle 75 Watts of RF power. They power load will also have a chimney to provide a vacuum path between the inside of the array and the vacuum tank. The reflection coefficient of the power load should be less than –15 dB.

6. The TWT supports.

   There will be 6 TWTs attached to the tank. Since each TWT will come with microwave and water connections, these supports should be placed for convenient access and not interfere with other tank components.

7. The array supports.

   The array supports should keep the array deformation to less than 0.020 inches.

8. The array.

   The array includes the input waveguide pockets, the slotted foils, the absorbing sidebars, and the isolating absorber pockets. The major concern is to keep the beam-pipe vacuum less than 5.0x10-8 Torr while the tank is subjected to 600 Watts of TWT power. The isolating absorbers should provide 20 dB of isolation.